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GAS HEAT *in* INDUSTRY

Vol. XIII March, 1950 No. 150

The Manufacture of Leather Boards

Gas Utilisation in Drying Operations

THE Avalon Leatherboard Company, Street, Somerset, makes leatherboard for the shoe trade and is closely associated with the well-known, shoemakers, C. and J. Clark Ltd., also of Street. C. and J. Clark Ltd. take a small fraction of the Company's output, the bulk going to the shoe-making centres of Leicester, Northampton, Norwich, the Rossendale Valley, and to certain foreign countries.

The Company's mills are set in the heart of the country and employ 150 people—a large number for this trade in which the manpower is small in relation to the size and value of the output.

The raw materials for the process are essentially scrap and consist of scrap leather, waste paper, waste rope and twine, and the equipment used in the preparation of the raw materials has been specially designed for this particular process.

Two distinct types of leatherboard are manufactured (a) a light flexible board from which stiffeners and insoles are cut, and (b) a heavy stiff board which is used principally for heel lifts.

For the light board, chrome tanned leather scraps are reduced to a very fine state and mixed with pulped paper and finely divided rope in pulping machines for about 4 hours. The resulting product is pumped to a storage tank and from there to machines where it is sprayed on to a quickly revolving felt band moving

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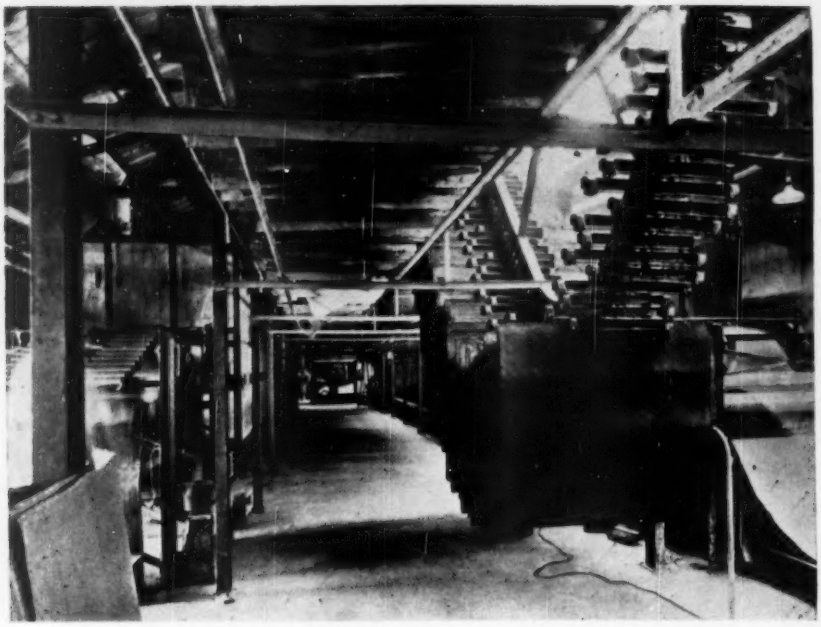


Fig. 1

on a series of rollers. A large percentage of water falls through the felt, and layers of pulp are laid until the predetermined thickness is arrived at, when an automatic warning signal advises the operator. The sheet is then cut across.

The water and raw materials passing from the board machines fall into settling tanks, the heavier particles being precipitated and the clean water rising over a weir and being returned into the process stream. The solid contents of the tanks are removed periodically and re-processed, so that although a great deal of water is used in the process, it is only necessary to provide a minimum amount for make-up.

The wet boards are then interlined with felt and subjected to a pressure of 15 cwt. per sq. in. under a hydraulic press, during which operation a large proportion of the contained water is removed. The boards are then racked and subjected to a stream of hot air at high velocity until dry.

For the heavy board, scrap tanned leather is beaten to a powder in special machines and then mixed with approximately an equal proportion of pulped paper.

The mixing process is similar to that already described and the board machines are the same in principle, but incorporate automatic guillotines for cutting-off after the desired thickness has been reached. The first water is again removed by hydraulic press and the boards now pass to a conveyor belt which is constructed of wire, 2 in. mesh. The conveyor leads into the first zone of a Spooner combined gas and steam heated conveyor oven, the dimensions of which are 80 ft. long × 8 ft. wide × 10 ft. high in which air under pressure is supplied by fans situated at the top and bottom of the ovens and the heated air is circulated.

The oven has three zones with an opening of approximately 2 ft. between each section. The first or hot zone is steam heated and contains, in addition, two Spooner high velocity gas burners, the flames of which are projected through tunnels situate above and below the conveyor belt, and so positioned as to avoid flame impingement. The burners work in

conjunction with a Spersom thermostat and relay valve, and provide the necessary boost to the first chamber, in order to bring the boards sufficiently high in temperature to facilitate drying in the heating zones.

Figs.1 and 2 show the dryer and the conveyor systems from opposite ends.

The speed of the conveyor is 1·6 ft. per minute and at the end of the travel a further drying time is allowed in air in the vicinity of the ovens for 16 hours, after which the boards are passed through calender rolls and finally trimmed by guillotines. The thickness of the boards varies from $\frac{3}{8}$ in. to $\frac{7}{8}$ in.

Production Details

Light Board

Size 3 ft. 8 in. × 3 ft. 0 in.
Weight before drying 14 lb.
Weight after drying 4 lb.
Production per week 25 tons.

Heavy Board

Size 4 ft. 2 in. × 3 ft. 0 in.
Weight before drying 28 lb.
Weight after drying 11 lb.
Production per week 32 tons.

Peak gas consumption 12 therms per hour (two ovens).

The gas has a C.V. of 460 B.Th.U. per c. ft. and a sp. gr. of 0·5.

Temperature of drying (Zone 1) 250° F.

Temperature of drying (Zones 2 and 3) 230° F.

Steam pressure of drying ovens 20/30 p.s.i.

The boards are systematically subjected to physical and chemical testing in the Company's own laboratory. Although the whole of the production is at present absorbed by the shoe trade, there is an enormous potential market for this class of material in the manufacture of travel goods, book binding, electrical insulation, motor car panels, wireless equipment and packages for specially delicate equipment of all kinds.

(Prepared from a Report of the Industrial Gas Development Committee — South - Western Gas Board.)

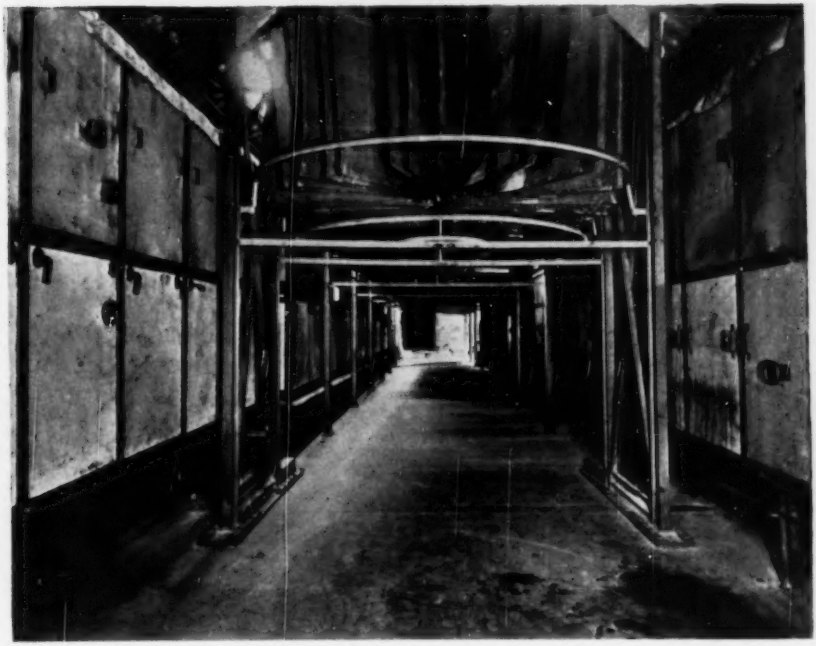


Fig. 2

Automatic Temperature Controls

Temperature Measurement of Molten Aluminium in Casting Production

Based on information supplied by Honeywell Brown Ltd., Wadsworth Road Perivale, Middlesex

ALUMINIUM foundrymen have long been aware of the need for accurate, economical methods of measuring the temperature of molten metal while in the melting pot and foundries. Short-circuiting action of the molten aluminium occurs at the point where the couple enters the bath, resulting in actual measurement of the surface temperature which

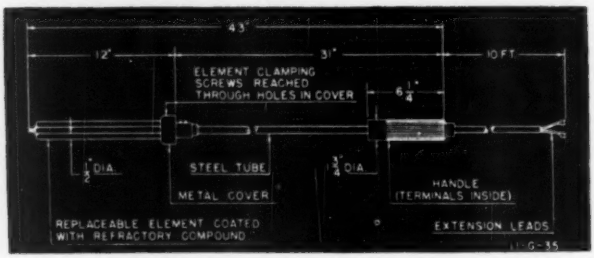


Fig. 1
Portable molten aluminium thermocouple

while being poured. Because of the conditions under which such a system has to operate its development presented a difficult problem to instrumentation engineers. The qualities essential to economical and efficient foundry practice are, namely: (1) ability to measure a truly representative bath temperature; (2) high speed response; (3) durability; (4) low maintenance; (5) easily read scale; (6) lightweight and balanced construction.

The ElectroniK indicating and recording instrument is suited to foundry usage, and is giving highly satisfactory service under similarly unfavourable operating conditions often encountered in steel mills and glass plants.

The Portable Thermocouple

Although the bare wire thermocouple has long been used by foundrymen, it does not provide the precise accuracy now demanded by so many differs from the true bath temperature.

The contact or separate wire couple is also widely used in foundry practice. Since this couple is dependent in its operation upon the establishment of a good electrical circuit between both couple wires and the molten

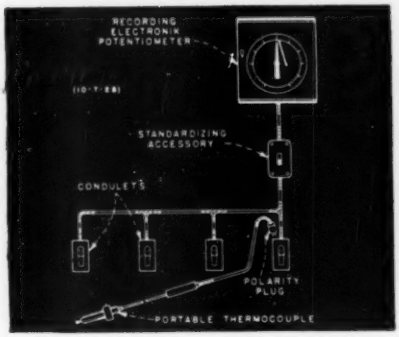


Fig. 2. Details of multiple installations

metal, it is important that the wires be kept clean and bright to prevent erratic instrument readings. There is also the possibility of parasitic currents being generated by the oxides and fluxes in the molten metal. While this type of couple has given satisfactory service in many cases, there exists a large demand for the more accurate couple.

Construction

The Brown portable thermocouple, illustrated in Fig. 1 consists of a steel tube approximately 31 in. long, having mounted at one end a shielded terminal block to which the thermocouple element is connected. This terminal block is protected from splashing metal and mechanical shock by a pressed metal cover. From the handle grip, which encloses the extension lead terminals, projects a 10 ft. length of flexible rubber-covered extension leads which connect the thermocouple to the recording and indicating instrument, or to the conduit mounted extension leads, in the case of a multiple installation.

The thermocouple element itself is largely responsible for the speed of response and the ability of the couple to measure truly representative temperatures. The replaceable element is 12 in. long and has its hot junction lap-welded. With the exception of the hot junction and a small portion of the "cold" end, the couple is covered with braided Fibreglass and coated with a special refractory which insulates the couple at the bath surface, thus enabling it to measure true bath temperature rather than surface temperature.

Installation

Where a single thermocouple is used with one recording and indicating instrument, the ElectroniK and the standardising accessory are usually mounted near the point of measurement.

Multiple units should be installed where distances are great or where utility is improved by using one permanently connected thermocouple. Condulets, permanently wired to the instrument (Fig. 2), are located adjacent to each furnace, and a heavy-duty polarity plug is attached to the extension lead of the thermocouple. A rack or counterweighted overhead support hanger should be provided to support the thermocouple, when not in use, thus precluding the possibility of damage to the temperature-sensitive tip.

To measure a temperature, the operator immerses the couple several inches below the surface of the bath and holds it there until the instrument indicates a steady reading for a few seconds. The chart record is evidence of a stabilised reading and shows that the thermocouple has not been removed before measuring the actual bath temperature. This entire measuring operation requires less than a minute.

Multiple Installation

In the case of a multiple installation, the thermocouple is plugged into the desired condulet and the temperature measured as described above.

After the temperature has been noted, the couple is withdrawn, adhering metal is removed by shaking the handle, and the couple is ready for another immersion.

Control for Diecasting Operation

Progressive thinking among metal processors has resulted in significant changes in the control instrumentation on large pot type heat treating and melting furnaces. In one diecasting plant, for example, the three melting furnaces were equipped initially with indicating millivoltmeter pyrometers with two-position control. For several years there were almost continuous controversies between the diecasting machine operators and the furnace operators as to the temperature of the molten metal in the furnaces. "Too hot" or "too cold" were the remarks frequently heard in the plant. When the metal was overheated, excessive dross resulted, and in extreme cases, part of the alloy "cooked out." Low temperature, on the other hand, resulted in a lack of fluidity.

Control Problem Recognised

The complexity of the control problem was revealed after an ElectroniK recorder was installed.

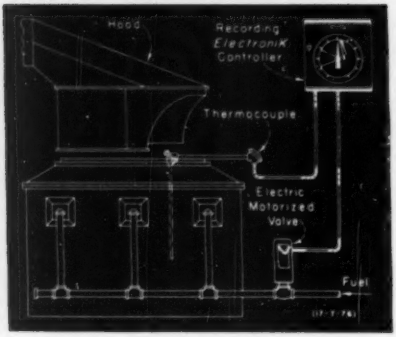


Fig. 3. Details of control of die melting furnace

This very sensitive instrument revealed that temperature drops of as much as 200° F. took place when cold scrap or pigs of fresh stock were added to the furnace. The large amount of metal added necessitated the use of a very large gas supply line for rapid heating, and under these conditions a temperature overshoot of as much as 100° F. was also revealed. Although there was no way of preventing the drop in temperature, the control system eliminated the excessive temperature surges, thereby yielding unforseen gains.

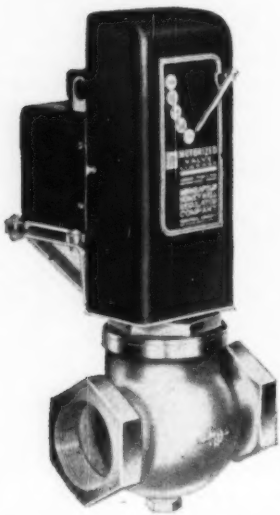


Fig. 4. Modutrol motorized valve

The following comments were received from the customer about the new control system:

"Except for changing charts and inking the pen on the recording temperature controller, the only maintenance necessary over a period of one year consisted of the installation of a new dry cell. The two other furnaces, which were still controlled by indicating millivoltmeter pyrometers with two-position control, required the installation of 10 new crucibles within one year. The furnace equipped with the controller, on the other hand, had not required the installation of a single new crucible."

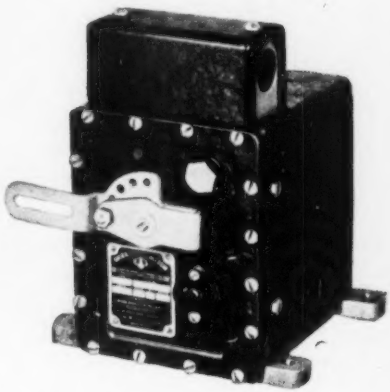


Fig. 5. Modutrol control motor

Installation

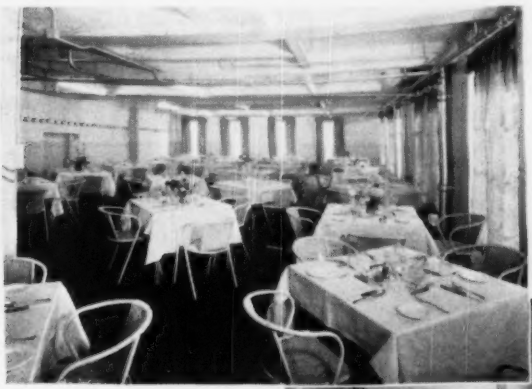
A recording controller with two mercury switches and a motor which operates the fuel valve form the basis of the control system. By connecting a 135-ohm potentiometer to the terminals of the motor, three-position control is obtained. An indicating plate graduated 180° between open and closed facilitates reproduction of potentiometer settings.

The control action is such that, when the molten metal temperature is above the set point, the gas valve is closed. When the temperature is just below the set point, the valve is driven to an intermediate position, and should the temperature drop to more than

approximately 35° below the set point, the valve is driven wide open, thus giving maximum pick-up. The manual potentiometer is set at a point which will provide an intermediate valve position capable of maintaining the desired temperature so long as no cold metal is added.

Very little experimentation is necessary to determine the optimum setting of the mercury switches in the pentiometer. The width of overlap should be sufficient to hold the temperature overshoot within reasonable limits without causing excessive time delay in returning it to the set point.

Since temperature changes are detected almost instantaneously, corrective control action is instituted as soon as the change takes place.



View of the third floor dining-room at the new Babcock and Wilcox staff canteen

Second floor still-room, catering for 100 diners at one sitting

NEW LONDON OFFICE CANTEEN

A NEW canteen for the city office staff of Babcock and Wilcox Ltd. has recently been opened in Cutler Street, Houndsditch.

Housed in a building of four storeys, this canteen is of modern design and decoration throughout, quite on a par with the most up-to-date West End restaurant. It is fitted with mechanical extraction plant, refrigerated cold rooms and service lifts. There are dining-rooms on three floors, each with a separate still-room.

The canteen was planned and installed by R. and A. Main Ltd., and the well-designed kitchen, which occupies the top storey, includes the following service equipment finished in vitreous enamel and chromium-plating:

A central battery of four 24 in. ovens surmounted by three solid and open-type unit hotplates and pot rack. This battery is extended at one end with a bain marie (with hot closet under) and a cold water swivel arm supply. There are two batteries of two steaming compartments, three gas boiling pans, gas stock-pot stove, gas-heated roasting oven, gas griller, two-pan fish fryer, gas-heated double deck pastry oven, potato chipper, potato peeler, 30-quart capacity mixing machine, electric slicing machine, gas-heated boiler sets with 2-gallon capacity milk and coffee urns, coffee boiler set with fountain pressure boiler, gas-heated double-tier hot cabinets and hot closets, joinery and sink equipment and mechanical washing machine.

Recovery of Waste Heat from High Temperature Flue Gas

IN all appliances which have high temperatures in the working space it is inevitable that the flue gases leave the working space at or above that working temperature, and carry with them a large proportion of the total quantity of heat supplied as fuel. On the other hand, the only heat which it is necessary for the flue gases to contain is that required to prevent condensation, and in the case of natural draught appliances the heat required to produce the motive force necessary for moving the various gases through the appliance.

Except in those relatively rare cases where recuperation or regeneration results in the recovery of some of this heat, it is normally wasted. Utilisation of this waste heat for water heating, or, more commonly, steam raising is a well recognised possibility, but has in the past only been considered worth while in large installations such as carbonising plants. Present day conditions however, are tending to make smaller installations profitable, and this article is concerned with the development of a small waste heat boiler suitable for easy application to existing equipment. With this limitation in mind, therefore, its construction has been deliberately kept simple to enable it to be fabricated from readily available materials, and also to keep the pressure loss by the flue gases reasonably low.

Experimental Boiler

In order to assess the practicability of the ideas described above, it was decided to make up and fit a small boiler in the flue of a permeably lined crucible furnace of 80 lb. (brass) capacity. This furnace has, in effect, induced draught provided by the eductor which is used to pull the products of combustion through the permeable lining, and therefore the experimental boiler could be fitted with confidence that the performance of the furnace would not be affected, since the frictional resistance of the boiler could be overcome by adjustment of the air pressure at the eductor. It might be emphasised here, however, that it should be possible to apply a similar boiler to many natural draught appliances, the additional friction loss being, if necessary, compensated by some extra height of the flue.

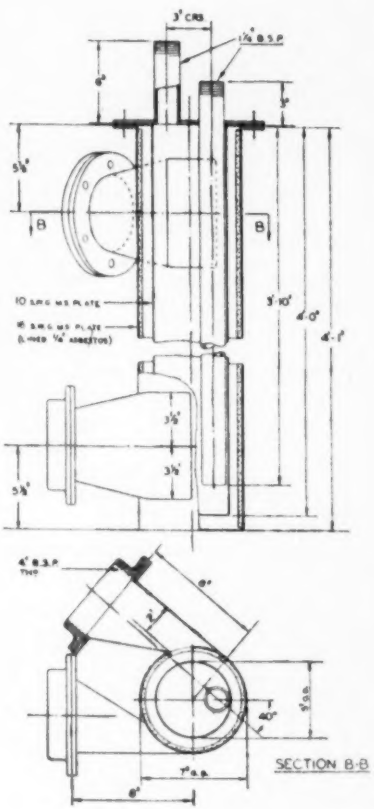


Fig. 1

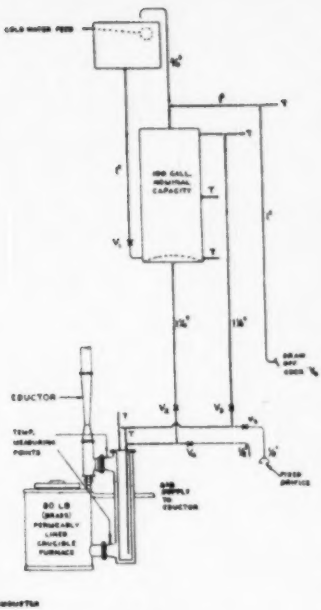


Fig. 2

The boiler installation used is shown in Fig. 1, and is made of three parts. The first is a length of 7 in. o.d. flue with tangential inlet and outlet connections for the flue gases and a flange at one end, the other being closed. The primary object of this arrangement was to provide that the boiler itself could be easily inserted in or removed from the installation without any major dismantling of the crucible furnace or its flue system; this is felt to be a necessary feature of any installation of this nature and necessitates side outlet at one end at least of the portion of the flue in which the boiler is mounted. Side entry at the lower end was necessary if excessive height was to be avoided, and in both cases tangential rather than radial connections were thought preferable as likely to give a higher gas velocity over the boiler surfaces, and to lengthen the path of the gases over those surfaces. This length of flue was lined with ¼ in. thick soft asbestos to provide some degree of insulation.

The second item is a cover plate carrying two pipes, one of which projects through the flange to the bottom of the boiler and is the return pipe.

The third item is a stop ended cylindrical boiler shell 5 in. o.d. of 10 s.w.g., M.S. plate, with a flange at its open end. In assembly this flange is held, with suitable gaskets, between the corresponding flanges on the first two items, the whole arrangement permitting easy inspection and cleaning of the inside of the boiler as well as its removal from the flue already referred to. The exact disposition of the two tangential connections, which were at 40° one to another was governed by local conditions and has no other significance.

The boiler was connected to a gravity circulating system of normal design with extra connections to enable a thermal efficiency test to be carried out. This layout is given in Fig. 2, and Fig. 3 is a photograph of the actual installation.

Experimental Work

Two series of tests were carried out on this installation. The first was a thermal efficiency test designed to obtain a heat balance under steady conditions, and hence give some indication of whether enough heat transfer surface had been provided, and generally to provide design data for other installations. The second was a series of tests in which the furnace was used for its normal purpose of melting metal. This provided information as to the actual quantities of hot water obtainable in practice, the results being, of course, peculiar to this type of work, involving as it does, intermittent use of the appliance.

A small crucible furnace is probably the extreme case likely to be met with in the direction of intermittently operated high temperature equipment, and most types of plant to which a waste heat boiler might be fitted may well conform more nearly to the steady conditions of the first series of tests.

Thermal Efficiency Test

The principle of this test was that water was passed at a steady rate through the boiler and its temperature rise measured. The furnace was run at a fixed gas rate such as would maintain

a reasonable temperature in the furnace; this was of necessity somewhat lower than the gas rate used when melting metal.

For the test, valves V_1, V_2 and V_5 were open, and valves V_3, V_4 and V_6 were closed. The water rate was controlled by a fixed orifice at the outlet of V_5. The test figures may be summarised as follows:—

Temperature of furnace chamber	1,200° C.
Temperature of gases at inlet to boiler	823° C.
Temperature of gases at outlet from boiler	400° C.
Temperature lost by gases in passing through boiler	423° C.
Temperature of water at inlet to boiler	76° F.
Temperature of water at outlet from boiler	154° F.
Temperature gained by water in passing through boiler	78° F.
Pressure in combustion chamber	0 to + 0·05 in. w.g.
Pressure at inlet to boiler	− 1·3 in. w.g.
Pressure at outlet from boiler	− 1·6 " "
Pressure loss through boiler	0·3 " "
Gas rate (uncorrected)	278 c. ft./hr.
C.V.	503 B.Th.U. per c. ft.
Water rate	537 lb./hr.
Flue gas composition CO_2	5·2%
O_2	11·6%
Flue gas rate (calculated from above)	2,958 c. ft./hr.

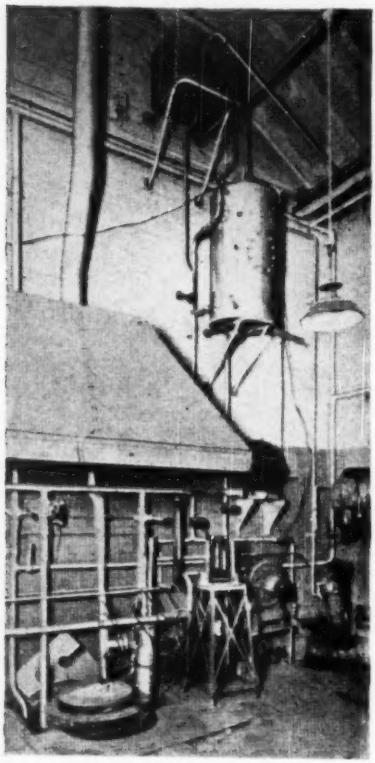


Fig. 3. Shows actual installation. With hot water storage tank of 100 gal. capacity

From these experimental results a heat balance can be constructed. This is shown in the form of a Sankey diagram in Fig. 4. It will be noticed that no allowance has been made for the heat put into the charge in the furnace. This is because the figures refer to a test carried out under equilibrium conditions with the sole object of finding the thermal efficiency of the waste heat boiler installation.

From Fig. 4, the following thermal efficiencies are obtained:—

Thermal efficiency of boiler with respect to the whole installation:—

$$\frac{\text{Heat into water}}{\text{Heat input to Furnace}} \times 100 = 30{\cdot}0 \text{ per cent.}$$

Thermal efficiency of boiler itself:—

$$\frac{\text{Heat into water}}{\text{Heat in gases leaving Furnace}} \times 100 = 42{\cdot}3 \text{ per cent.}$$

From these figures two facts emerge; firstly that 30 per cent. of the total heat input has been reclaimed by the use of the boiler, which is a useful economy, and secondly, that with an effective heat transfer area of 5¼ sq. ft. (neglecting the bottom) the boiler has only 42 per cent. efficiency the flue gases leaving at 400° C. It is clear that increased boiler surface could be employed with advantage, and the following table indicates the heating area which may be expected to be necessary for a given thermal efficiency.

Boiler efficiency %	*Outlet flue gas temp.* °C.	*Heat transferred B.Th.U. per hour*	*Heating surface sq. ft.*
42·3	400	41,900	5·24
50	323	49,300	6·85
60	223	59,300	10·0
70	123	69,300	16·5

These figures assume a constant overall heat transfer coefficient, and are based on the use of a logarithmic mean temperature difference calculated for concurrent flow. The increase in area required to increase boiler

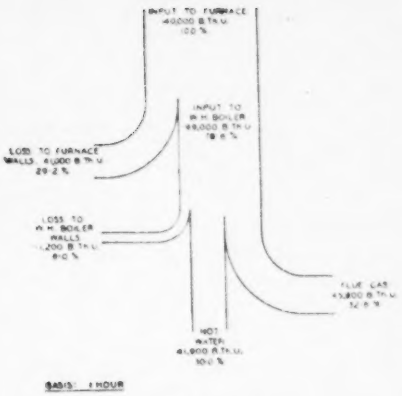


Fig. 4

efficiency from 60 per cent. to 70 per cent. is a warning against the calculation of heat transfer areas on a *pro rata* basis instead of using fundamentally sound methods, especially where concurrent flow is concerned. Details of these calculations are given in the appendix.

The assumption that the overall heat transfer coefficient is independent of temperature is not strictly true, and this should be allowed for by providing a safety margin over the calculated areas given above. Margins of 5, 10 and 15 per cent. are suggested for 50, 60 and 70 per cent. efficiency respectively. This marginal allowance cannot be calculated with sufficient accuracy, and is a matter which requires further attention

Water Output Tests

These tests were designed to give some idea of the amount of water which could be obtained from the installation in practice. From them a figure for thermal efficiency can be obtained which will include all losses from the pipe work and storage tank of the water system, for imperfect stratification in the storage vessel, and for the utilisation factor of the crucible furnace. Two sets of tests were carried out, one in which aluminium was melted, and one in which brass was melted.

For these tests V_1, V_2 and V_3 were open and V_4 and V_5 closed; V_6 was operated as the draw-off test required. The procedure adopted was to use the crucible furnace in the normal way, and at midday and the end of the day draw off the hot water above 110° F. The heat content of this water then represents the total useful heat which has been recovered from the flue gases. This statement, of course, implies that water below 110° F. is of no practical value for washing purposes, and the adoption of this criterion inevitably reduces the overall thermal efficiency of the process. It is important, therefore, that it be realised that the figures quoted for these tests assume that washing purposes are being catered for, rather than any other use which may be found for water at lower temperatures.

The results obtained from these tests are summarised in Fig. 5. Two days' results are quoted; on the first day 23 lb. charges of aluminium ingots were melted and poured and on the second day 70 lb. charges of brass ingots were melted and poured. In both cases the charges were preheated in the normal way by standing them round the rim of the furnace.

Examination of Fig. 5 brings to light the following points:—

1 The general level of overall thermal efficiency for a day's run is considerably lower than the 30 per cent. known to be obtained under steady conditions with flue gases at 800° C.

This is due to

(a) heat loss from the water system.

(b) intermittency of operation of the furnace.

(c) heat capacity of the furnace, boiler, etc., during initial heating up.

(d) the self-imposed limitation that regards water at below 110° F. as useless.

2 The thermal efficiency during the morning runs is lower than that during the afternoons. This is clearly due to heat capacity of the system.

3. The thermal efficiency during the morning is lower for the brass melting test than for the aluminium melting test. This is partly due to the fact that the total heat input for the morning was lower for the

brass test, and partly that the initial water temperature was 12° F. lower for the brass test than for the aluminium test.

4. The above comments suggest that a true comparison should be discoverable from the results of the afternoon tests, since presumably any differences in initial conditions will by then have been smoothed out.

The afternoons do give a considerably increased efficiency owing to the system being already warm so that a closer approach to the equilibrium conditions represented by the first series of tests is possible. The brass test has however, given an efficiency almost double that of the aluminium test. This is not, as might have been expected, due to a higher flue gas temperature in the brass melting test; these temperatures were in fact very similar during the two tests. The fact that the gas was turned off between melts to the extent of 47 per cent. of the time during the aluminium test and only 22 per cent. during the brass run has undoubtedly contributed to the increased efficiency, and it is thought probable that the inlet water temperature during the afternoon of the brass run was higher than that observed during the morning, which would introduce some error, not more than about two units of percentage, into the thermal efficiency calculations.

Conclusions

The tests described have given information concerning the extreme types of service which might be expected of an installation of this type. It has been shown that, on the one hand, a small waste heat boiler cheaply and easily constructed, can be expected to give a heat recovery of the order of 30-50 per cent. of the gross heat input when applied to a continuously operated furnace with flue gases at 800° C. This would undoubtedly be worth while in many cases where furnaces operate for long periods under steady conditions. On the other hand, the crucible furnace tests represent what is probably the extreme of intermittent use, and

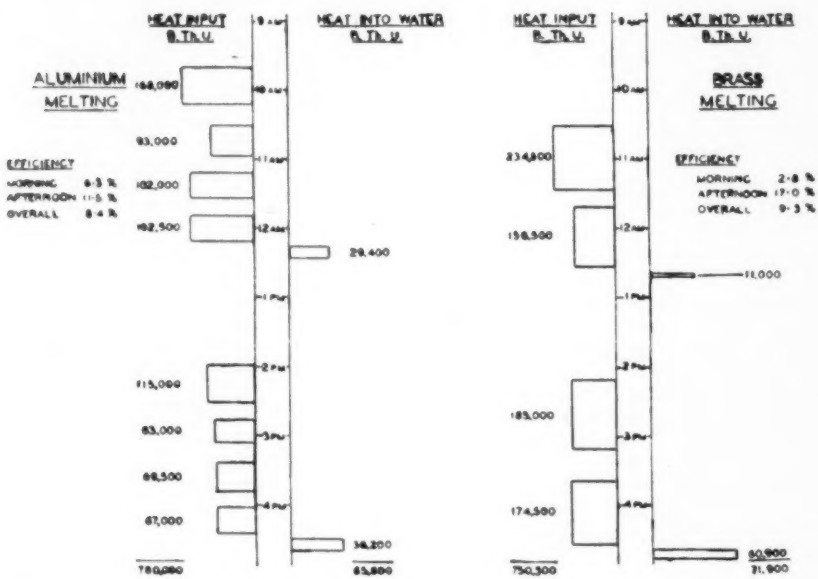


Fig. 5

it is clear that this has a profound effect on the resultant thermal efficiency. In cases where furnaces are thus intermittently used, the decision to fit a waste heat boiler is subject to such considerations as whether it will save the capital cost for a heating installation which would otherwise have to be provided. For instance, there is no doubt that the installation here described would provide ample hot water for the washing needs of the small foundry in which it was situated, and would be worth while if that foundry were isolated from other sources of hot water supply.

Fifty per cent. Saving

It should be realised that the boiler here described was used with a furnace having a maximum gas consumption of some three therms per hour. This is relatively small and would therefore be expected to give lower efficiencies than larger units with their correspondingly lower surface losses. For larger units the potential saving of 50 per cent. of the heat input should prove a very attractive proposition. As a guide to those who wish to design larger units, the tests described give an overall heat transfer coefficient from flue gases to water of 8·4 B.Th.U./ (sq. ft.) (hr.) (°F.). It should not be forgotten that it is the temperature and volume of the flue gases which control the boiler performance, rather than the maximum gas consumption; this is especially relevant where the furnace is thermostatically controlled.

A further point is that the system was not lagged, which would permit a loss of some 3,500 B.Th.U. per hr. This loss could be halved by an average lagging and this would diminish the disadvantage of intermittent furnace operation.

APPENDIX

Calculation of Heating Surface

This appendix sets out more fully the methods of calculation adopted in the preparation of the table showing the heating area required for a given thermal efficiency.

The first line of the table represents the experimental results on which the calculations are based. From them an overall heat transfer coefficient is calculated as follows:—

Inlet temperature of hot gases	1510° F.
Inlet temperature of water	76° F.
Temperature difference at inlet	1434° F.
Outlet temperature of hot gases	753° F.
Outlet temperature of water	154° F.
Temperature difference at outlet	599° F.

Hence, the logarithmic mean temperature difference is given by:—

$$\frac{1434-599}{2{\cdot}303 \log (1434/599)} = 952° \text{ F.}$$

The overall heat transfer coefficient is therefore:—

$$U = \frac{41{,}900}{5{\cdot}24 \times 952}$$

$$= 8{\cdot}4 \text{ B.Th.U./(sq. ft.) (hr.) (°F.)}$$

In order to calculate the conditions for, say, 60 per cent. thermal efficiency the first step is to calculate the quantity of heat which will have to be transferred, and the new outlet temperature of the gases; both these can be obtained by simple proportion, and are found to be 59,300 B.Th.U. per hour, and 223° C. (433° F.) respectively. The water rate is assumed to be increased to the extent necessary to keep the outlet water temperature unchanged.

A new logarithmic mean temperature difference is now calculated and used together with the overall heat transfer coefficient which is assumed constant, to derive the new value of the heat transfer area required. Thus for the example under consideration:—

Inlet temperature of hot gases	1510° F.
Inlet temperature of water	76° F.
Temperature difference at inlet	1434° F.
Outlet temperature of hot gases	433° F.
Outlet temperature of water	154° F.
Temperature difference at outlet	279° F.

Hence, the logarithmic mean temperature difference:—

$$\frac{1434-279}{2{\cdot}303 \log (1434/279)} = 703^\circ \text{ F.}$$

and the area required is given by:—

$$A = \frac{59{,}300}{8{\cdot}4 \times 703} = 10{\cdot}0 \text{ sq. ft.}$$

If, instead of logarithmic mean temperature difference, the arithmetic mean had been taken, the value obtained would have been 857° F., leading to an area of 8·2 sq. ft., and involving some 20 per cent. error. A *pro rata* calculation based simply on the ratio of the two heat quantities gives an area of 7·4 sq. ft., involving 26 per cent. error.

These errors are even greater in the calculations for 70 per cent. efficiency this being because the ratio between inlet and outlet temperature difference is even greater.

The corresponding values are:—
Logarithmic mean temperature difference, 498° F. leading to an area of 16·5 sq. ft.
Arithmetic mean temperature difference, 767° F. leading to an area of 10·7 sq. ft. and involving 35 per cent. error.
Pro rata calculation leading to 8·7 sq. ft., involving 47·5 per cent. error.

(Prepared from a Report of the Industrial Gas Development Committee — North Thames Gas Board.)

MR. W. DIETERICHS

IT is with the deepest regret that we announce the death of "Bill" Dieterichs.

The North Thames Gas Board has indeed lost a master craftsman with a flare for design and an ability to get things right largely based upon his

forty years' experience in the gas industry. He began as a gas fitter apprentice in 1910, and in the first world war rose to the rank of captain in the Royal Engineers. In 1927 he was in charge of the Gas Light and Coke's industrial gas workshops and was there during the development of industrial gas usage which took place in the years which were to follow. His work in this respect took him into the pottery and ceramic industries, paint and varnish making and applications; and in fact, wherever industrial gas is used, his name is an intrinsic part of many of the industrial appliances. In July, 1945, he was appointed manager of Watson House, and he retained this appointment under the new North Thames Gas Board.

On the day of his funeral the staff of Watson House arranged for a private service to be held in Watson House where so much of his work was done; and at the funeral service itself, representatives of associations and organisations connected with industrial gas were in attendance.

Mr. Dieterichs was 54 years of age, and probably no other name will be associated with the development of industrial gas usage to the extent that his was.

Change of Address.—Megator Pumps and Compressors Ltd., have now moved their offices and showrooms from Feltham to 43 Berkeley Square, London, W.1.

Canadian International Trade Fair.—The Gauge and Tool Makers' Association will be occupying a stand of nearly 1,000 sq. ft. in the Automotive Building, Booth Nos. 1188-1194, at the Canadian International Trade Fair in Toronto during May and June, 1950.

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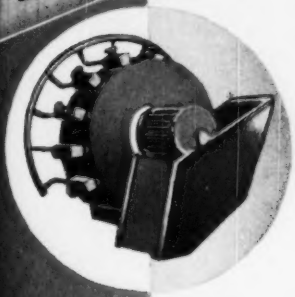

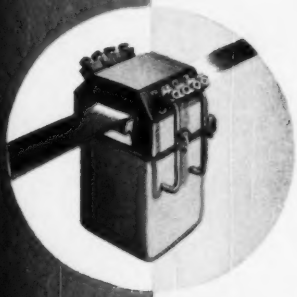

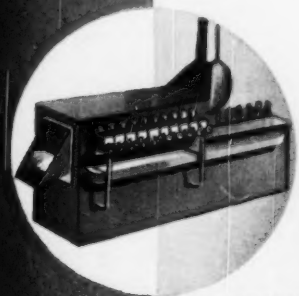

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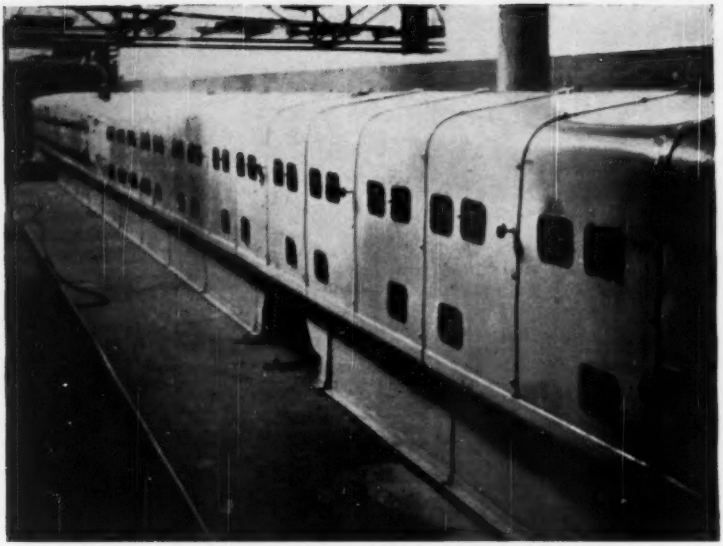

View of one of the 140 ft. long gas-fired biscuit-making ovens at the Premier biscuit factory, Johannesburg

Baking Biscuits by Gas in South Africa

by

Colonel W. R. GORDON, O.B.E., M.Inst.F.

TWO of the largest, the most important and the most interesting examples of industrial gas utilisation in Johannesburg are afforded by the factories of J. W. Quinn and Co. Ltd. and the Premier Biscuit Co. Ltd. These two concerns, which are under the same ownership and management have developed the use of gas in their various manufacturing processes, during the last 20 years, to such an extent that today they are the largest industrial gas users in the "golden city," with a consumption of about one million c. ft. of gas monthly.

Founded by the late John Quinn, one of the earliest mayors of Johannesburg, in 1896, Quinns amalgamated with the Premier Biscuit Company in 1935. This latter concern had been founded after the first world war and, in 1927, Mr. A. J. Fisher, the present technical director of the two companies, came out to South Africa to take charge of the biscuit factory and, in about the same year, the companies were joined by the present managing director, Mr. M. Posner. The first gas ovens were installed in 1930. But, up to the time of the amalgamation, the two businesses were comparatively small. Due to the progressive policy then adopted, the turnover has now grown to such proportions that the daily volume of trade done now is almost equal to the monthly turnover 20 years ago. As will be seen later, the firm is not resting on its laurels

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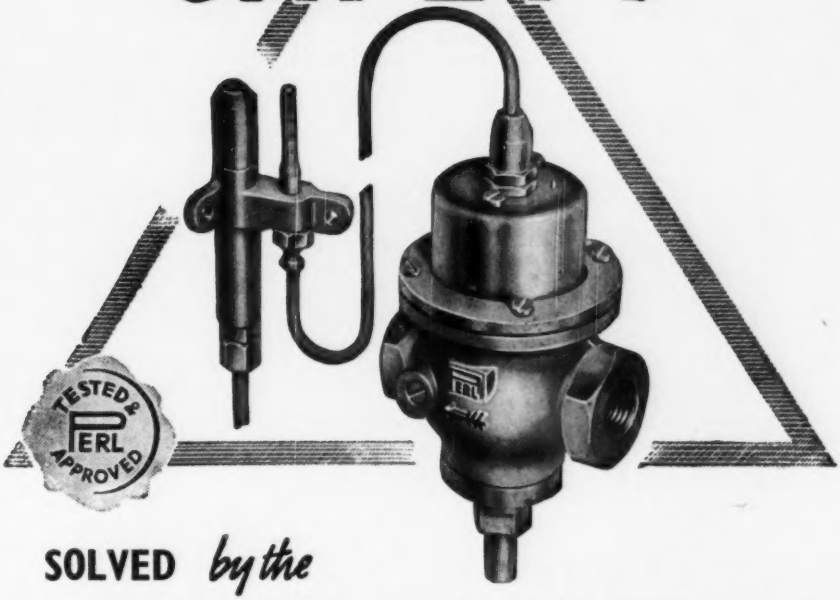

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and new gas plant is presently being installed.

At Quinn's bakery the gas is supplied through a 6 in. main via a Thorpe rotary meter, with a capacity of 25,000 c. ft. per hour. This main has superseded two others, now not used, of first 3 and then 4 in. in dia.

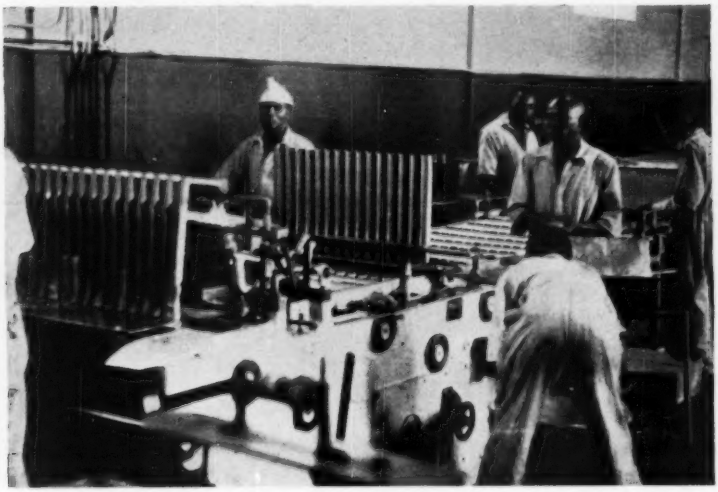
Large High Pressure Gas Oven

While a large part of the Quinn plant is devoted to the baking of bread with coal fired ovens, gas is employed for a variety of purposes. The largest gas installation consists of a 40 ft. long high pressure gas oven for making swiss rolls, for toasting rusks and for "home made" biscuits. This oven is fed by a continuously moving steel belt, the baking time for swiss rolls being 7 minutes. On the underside cleaning brushes are provided, two of which are steel and two of fibre, for cleaning the belt at each revolution. A control panel is fitted in the centre of one side of the oven for regulating both pressure and temperature.

At the delivery end of the oven the rolls, or other articles being baked, drop by a canvas conveyor belt to the floor below, where automatic machines spread the jam or buttercream and where the rolls are packed by hand. The labour employed is almost exclusively Native, with European foremen in charge.

Potato Chip Frying

In a nearby section of the factory is a small gas installation for potato chip frying. Here secondary, instead of pre-mixed air is used. An electric peeler is employed, as well as an electric slicer. The latter is centrally mounted over the four gas heated cauldrons, in which the chips are fried. By visual and manual experience the operators can tell to a nicety when the chips have been sufficiently cooked and are ready to be removed by a wire dredger.



View of the gas-fired biscuit creaming machine in use at the Premier biscuit factory, Johannesburg

Other uses for gas at Quinn's are for doughnut cooking and for hot plates employed in the manufacture of pancakes, crumpets and scones. In addition a wide variety of other products are made, including confectionery such as cakes, cornish pasties, steak and kidney pies, sausage rolls and the like. The cakes produced are of every type, comprising slab, sponges, wedding and birthday. Also, gas is utilised for the manufacture of Worcester sauce, for mayonnaise, for roasting the nuts in peanut butter, for lemon curd, mustard and gravy thickeners. Quite apart from its obvious advantages of cleanliness and

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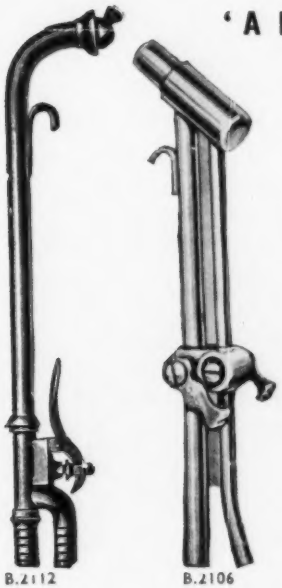

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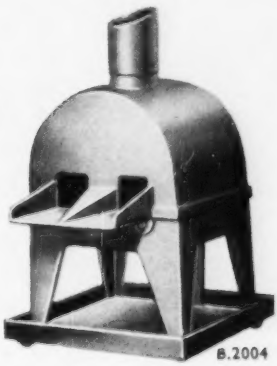

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Operating one of the gas-fired wafer-making machines used at the Premier biscuit factory

convenience, gas has proved itself indispensable to this company because of its ability to bring the ovens to the requisite temperature quickly and with the absence of any waste heat or standby losses.

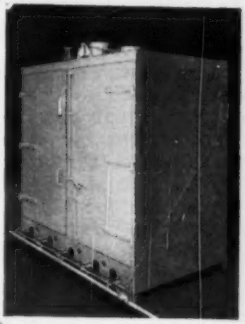
Band Ovens

At the Premier Biscuit factory, just about a mile from Quinn's, there are two band ovens, approximately 140 ft. long together with a three pan wide 60 ft. long gas oven. A third band oven, to replace a coal-fired oven is now in process of being installed. The gas installation is fed by three 6 inch lead-ins from the main, with a large fan type rotary Thorpe meter, each with a capacity of 10,000 c. ft. per hour. Each baking oven is fed through Selas air/gas pre-mixers, in order to maintain constant temperature control through internal governors, which ensure a constant mixture.

The baking time in the band ovens varies from 1½ minutes for Jewish bread to 20 minutes for biscuits like ginger nuts. In the process of mixing prior to baking, the flour is first sifted and all the impurities are removed. The dough is then mixed in machines of 1,000 lb. capacity for a period varying from 10 to 60 minutes, depending upon the type of article to be made. The dough is next taken to the "dough - breaks" or sheeting machines, on which it is formed into continuous sheets. These then pass through a number of rollers which, in turn, reduce the sheet to the required thickness of biscuit. The sheets then move on to the cutting and stamping mechanism, where the biscuits are cut to the design, shape and size needed. From there the biscuits are conveyed on a canvas belt to the steel bands which pass through the oven and on which the biscuits are baked. The waste dough, after shaping, is carried back by conveyor into the process once again, so that none is wasted. The natural grease in the biscuits prevents them from adhering to the steel band, which is buffed in similar fashion to the swiss roll oven at Quinn's.

Daily Output

After baking, the biscuits travel on canvas or wire belts where they are cooled for periods varying from 10 to 20 minutes. They then pass off to stacking machines, where they are stacked, like pennies, on edge. They are then taken and packed manually into packets or tins. The daily output of the two present ovens one of which is of British manufacture and the



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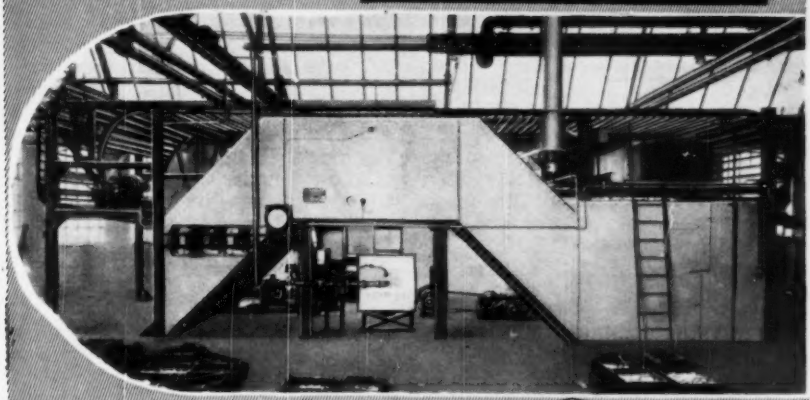

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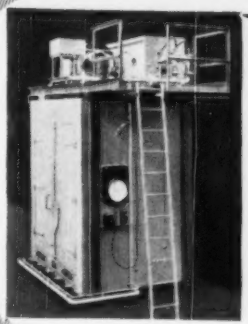

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other was made locally in the factory, is over a million biscuits per 8½ hour day. To achieve this rate of daily production the Premier Biscuit Company employs about 450 Europeans and Natives of whom some 25 per cent. are Europeans if all the clerical staff are taken into account. The staff at Quinn's, including those employed on delivery services, numbers over 400 Natives and some 200 Europeans.

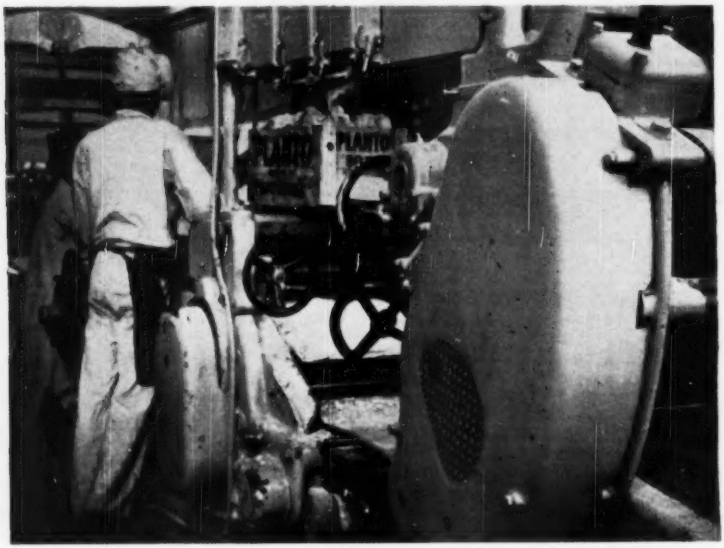
Among the type of biscuits made at the Premier factory are Marie, Cream Cracker, Ginger Nuts and Water Biscuits—in fact the complete biscuit range. In an adjoining factory working exclusively on this product at the time of my visit, matzos, the Jewish bread for the Passover, was being turned out at the rate of 10,000 lb. per day.

All the Quinn and Premier Biscuit products are sold throughout the length and breadth of the African continent. There is a ready sale for them, for example, in Kenya, Sierra Leone and Portuguese East Africa. During the war Premier were producing Army biscuits for the Union Defence Forces up north in the desert campaigns. In fact, after the disaster at Sidi Rezegh and the fall of Tobruk so many were lost, with the rest of the army's supplies, that the factory was working night and day to replace them.

Other Gas-Heated Machines

In addition to the biscuit baking ovens at Premier there are also gas-fired ice-cream wafer and cone making machines, as well as fully automatic biscuit-creaming machines. In this latter process the biscuits are taken and passed under a filling apparatus. The top biscuit is placed mechanically in position and the biscuits given a gentle squeeze. They then pass on to conveyor belts which take them through refrigerated tunnels in which the cream is set. Other gas heated machines include those for chocolate enrobing where, by a similar process, the biscuits pass through a continuous stream of chocolate.

It is a symptom of the rapid growth of South African industry, these days, that practically all the materials used in manufacture at both these factories, are South African in origin. The gas is supplied by the Johannesburg municipal undertaking and the fruit, sugar, eggs and butter are all local produce. Almost the only imported articles, except the capital equipment, is the paper required for packing.



Premier biscuit factory. The "dough-breaking" or sheeting machines being utilised for making matzos, the Jewish bread for the Passover

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Gas-Fired Spring Hardening Furnace

THE maintenance of a supply of small lubricator springs in a suitably hardened condition had become a matter of great difficulty to a firm of lubricator manufacturers. Apparently, these small springs varying in length from $\frac{3}{16}$ in. to $\frac{7}{8}$ in., had been submitted to various heat treatment contractors but in no instance were the results of heat treatment uniform, some of the returned springs being too brittle and some too soft, thus introducing the necessity for the testing of each individual spring prior to its use.

The problem was eventually solved and a method of heat treatment making use of a silica tube with a water quench was decided on in collaboration with the Leeds Gas Undertaking and the Metallurgical Staff of Leeds University. After some sample batches had been treated by this method, the firm in question asked for a small furnace to be built and supplied.

General Description

The furnace, a section of which can be seen in Fig. 1, is enclosed in a mild steel case mounted at a suitable height on angle iron legs. It operates on natural draught, and apart from the hearth piers, is lined throughout with Selfrac hot face insulating refractory.

The burner equipment comprises two 1 in. burner rails each fitted with eight refractory burner nozzles, supplied with an air-gas mixture by means 1 in. Aeromatic injectors. These burners give very keen well aerated flame on the governed gas pressure of $1\frac{1}{2}$ in. w.g. and with the maximum gas consumption of 0·7 therms per hr. (150 c. ft. of gas C.V. 468 B.Th.U. per c. ft. and sp. gr. 0·48) the furnace is capable of attaining 1,000° C. in under one hour, from cold. The maintenance rate is 80 c. ft. (0·37 therms) per hr.

Working Dimensions

The internal working dimensions are 6 in. wide by 12 in. deep by 5 in. to crown of arch, and a hole is provided in the front of the furnace to allow a 3 in. dia. silica tube to be inserted, which then rests on two firebrick piers during the heat treatment cycle. The 4 in. × 4 in. flue off-take is at the rear of the furnace, whilst provision is made for the insertion of a thermocouple at the front, above the silica tube. A Jeavons J11, $1\frac{1}{4}$ in. gas governor is fitted, control being by means of a 1 in. quadrant cock, whilst each injector is fitted with one $\frac{1}{2}$ in. independent control cock for lighting purposes.

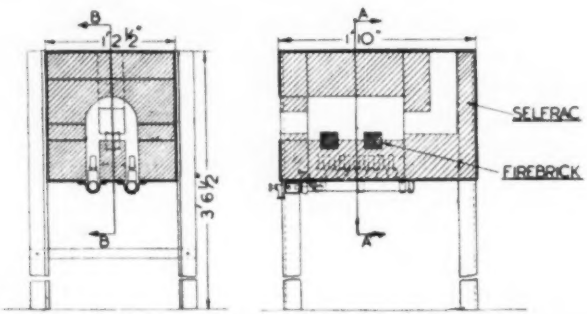

Fig. 1

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Method of Operation

A quantity of springs in an oily condition from the previous operation is loaded into the silica tube together with a small quantity of flake graphite, and a loose fitting cap is put on the open end of the tube so that any excess pressure may be released without allowing the inflow of oxygen, whilst at the same time the oil coating ensures a reducing atmosphere inside the tube. The assembly is then inserted into the hot furnace at 1,000° C. and allowed to soak for 4 to 5 minutes after which it is withdrawn, the cap quickly removed and the contents poured immediately into a 3 ft. deep quenching tank filled with water. The graphite serves to prevent the adhesion of the springs to the side of the tube, and their sticking together.

The question of ensuring that the springs separate immediately they are discharged from the tube, as would be appreciated, is one of the most important factors in ensuring uniformity of hardness throughout the batch, and the method outlined has proved most satisfactory in this regard. A silica tube is preferred for the purpose to ordinary mild steel, as with the latter scaling would occur, and hence such a tube would require periodical replacement.

Four thousand springs can be accommodated in the tube at one time, and this quantity can be dealt with, as previously outlined, in 4 to 5 minutes.

(Prepared from a Report of the Industrial Gas Committee—North-Eastern Gas Board.)

BRITISH INDUSTRIES FAIR

OVERSEAS buyers from Scandinavia visiting the Fair from 8th May to 19th May will benefit by concessions announced by four shipping services. Reduced fares will be allowed on the Gothenburg/London, Esbgerg/Harwich, Oslo/Gothenburg and Harwich sailings to travellers presenting official B.I.F. invitation cards. The respective companies are: Swedish Lloyd Steamship Co. Ltd., United Shipping Co. Ltd., Ellerman's Wilson Line Ltd. and the United Baltic Corporation expect to announce the same facilities on the Gydnia/London service during the Fair.

Safety in Gas Ovens

Scheme for On/Off Thermostatic Control

THE British Thermostat Co. Ltd., Sunbury, Middlesex, announce a gas control scheme No. 1, for large drying ovens, box ovens, conveyor dryers and similar gas-fired plant in which on/off thermostatic control only is desired. It has been specially designed to provide against the possible adverse consequences of incorrectly lighting-up pilot flame failing, mains gas supply failing, electricity supply or fan failing, a fall in gas pressure, and a defect in the control system, and is illustrated diagrammatically in Fig. 1.

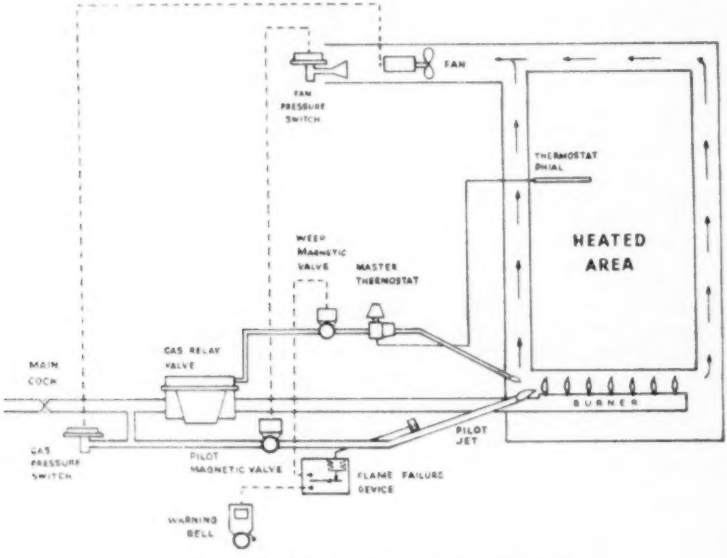
The lighting-up procedure is to set master thermostat and turn on main cock. If normal gas pressure and mains current is available, the gas pressure switch completes the circuit to the fan. As the fan commences, the fan pressure switch completes the circuit to the pilot magnetic valve and gas flows to the pilot jet. Light pilot with taper or gas match. After the pilot has been alight for some thirty seconds the flame failure device closes the circuit to the magnetic valve in the weep of the gas relay valve. This magnetic valve opens, causing the relay valve also to open and allow gas to flow to the main burner.

Safety Factors

In the event of incorrect lighting-up procedure, gas cannot reach the pilot burner, the weep outlet or main burners unless, in the first instance, the fan is running. Apart from manual switching, the fan only runs if it has been set into operation by gas pressure (at the gas pressure switch)—that is, after the main cock has been opened. Furthermore, gas reaches the main burners only after the pilot has been lit.

In the event of pilot light failure, this causes the main circuit of the flame failure device to break, with the result that the magnetic valve in the weep closes and causes the relay valve to shut off the mains gas. A second circuit is closed by the flame failure device, and this operates a warning bell or light, etc. In addition, the pilot gas flow continues unless the fan is switched off. Gas cannot reach the main burners until the correct lighting-up procedure is repeated.

If the mains gas supply fails, the pilot



Diagrammatic layout of control scheme No. 1

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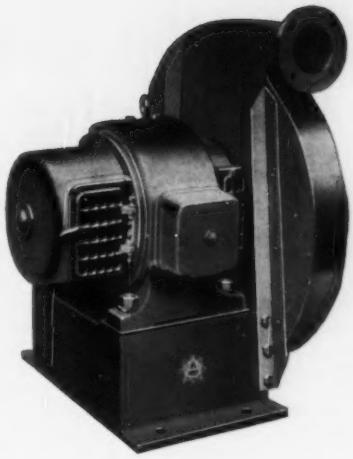

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light will naturally be extinguished with the result that, as stated above, the magnetic valve in the weep and the relay valve closes. The fall in pressure at the gas pressure switch stops the fan, which in turn breaks the circuit in the fan pressure switch and closes the pilot magnetic valve. Gas cannot reach the main burners until the correct lighting-up procedure is repeated.

Should the electricity supply or fan fail, the two magnetic valves utilised close automatically when not energised, shutting off the gas supply to the pilot burner, the weep line and the main burners. On fan failure the fan pressure switch breaks circuit, closes the pilot magnetic valve, and thus cuts off the supply to the pilot and thereby the main burners. The extinction of the pilot flame also causes the magnetic valve in the weep to close and shut off the weep flow. Gas cannot reach the main burners until the correct lighting-up procedure is repeated.

If gas pressure falls, the gas pressure switch breaks circuit, with the result that the fan stops and the entire gas supply is cut off. Gas cannot reach the main burners until the correct lighting-up procedure is repeated.

Should there be a defect in the control system, such as a failure of pressure switches, magnetic valves or flame failure device, the control system shuts down and remains inoperative until such time as the cause of failure is remedied.

GLAND SERVICE

IN the not too distant past the packing of glands was a very casual matter—anything from a bit of spun yarn to a bit of old rubber looked good enough.

But times have changed and nowadays the packing of glands has been brought up to a very fine art both as to materials and methods. We mention this whilst looking at a very excellent chart produced by the Crane Packing Co. Ltd. of Slough, which covers all industrial fluids from acetone to zinc chloride with sundry gases between from coal gas to butane. This should prove of inestimable value to the works engineer who wants to know that the glands of his many machines are rightly packed to keep a tight joint for such abominations as "raffinate," or even fruit juice. It will be certainly worthwhile for any works engineer to ask the Crane Packing Co. Ltd. of Slough for a copy of this chart.

Recent Gas-Fired Central Heating Installations

In the Newcastle Division of the Northern Gas Board

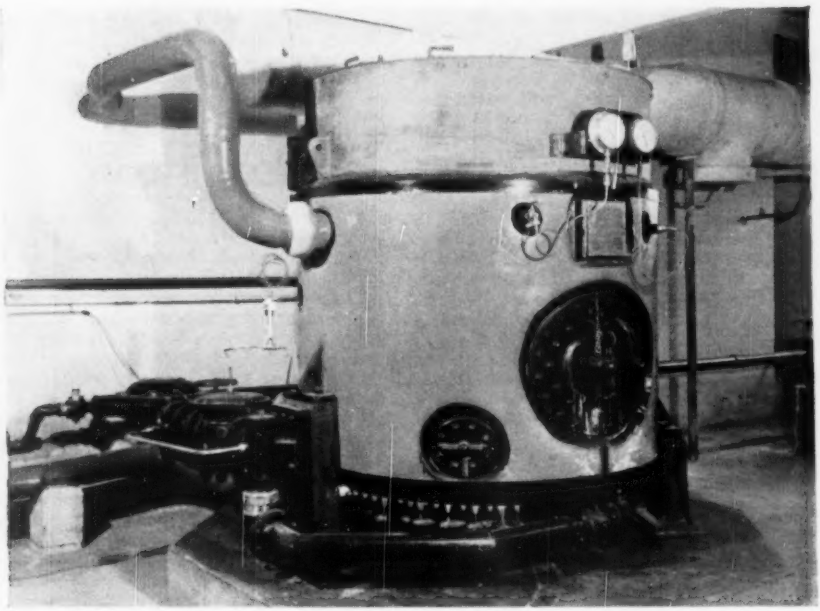
SCOTT AND TURNER LTD.

TYPICAL of the many large gas-fired hot water central heating installations which have been fitted and now operating in the Newcastle Division during the past eighteen months is that of Scott and Turner Ltd., Fawdon, near Newcastle-on-Tyne. A new extension to their existing works was completed in 1948 and is now engaged in the manufacture of tin packages and fillings for the well-known medicinal products.

The new buildings are laid out on modern lines and consist of two "L" shaped single storey blocks 185 ft. × 75 ft. × 15 ft. and 150 ft. × 75 ft. × 15 ft. high respectively, constructed of brick and ferro concrete each covered by a 75 ft. single span domed concrete roof.

Heating arrangements for the new extensions are provided by twenty-six overhead "Copperad" air heaters supplied with hot water at a temperature at the heater of 165° F. from the central heating boiler. The heater units each have a maximum output of 50,500 B.Th.U. per hour.

The central heating plant is located in a spacious boiler room and consists of one vertical 11D "Cochran Kirke"



The 11D "Cochran Kirke" Sinuflo installation at the works of Scott and Turner Ltd.

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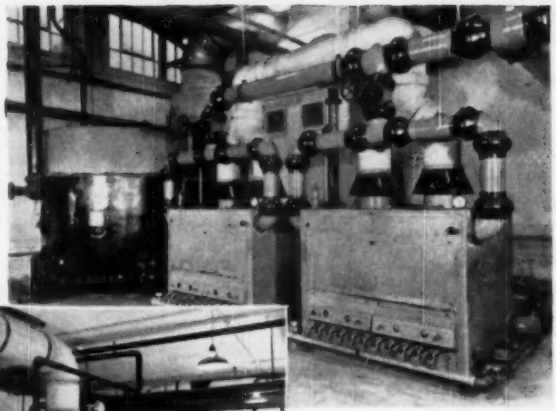
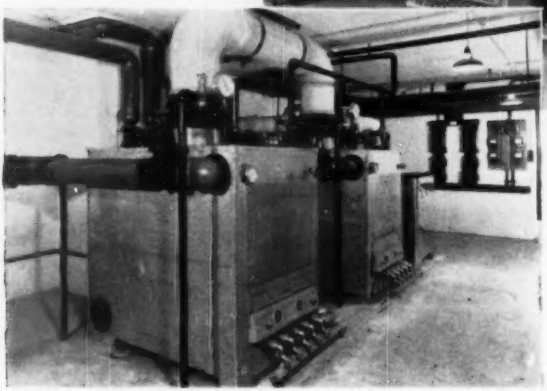
(Right) The central heating plant at the Team Valley Trading Estate works of Tyneside Safety Glass Ltd.





(Left) The two 3 GBA7 ideal boilers installed at the Convent De la Sagesse School at Newcastle

Sinuflo hot water boiler 5 ft. 6 in. dia. by 6 ft. 6 in. high, having a maximum rating of 2,070,000 B.Th.U. per hour with a gas consumption of 5,750 c. ft. per hour. Ample space is provided for an additional unit which may be required to cover any future extensions.

Gas to the burner equipment is taken from a 6,000 c. ft. meter through an 8 in. branch reducing to 4 in. in the boiler room and fitted with a main shut off cock, "Thorpe" combined cut-off governor and relay valve. A "Thorpe" pilot flame thermostat is incorporated with the cut-off governor to provide the necessary safeguard against the liberation of unlighted gas at the burners in the event of a temporary failure of the main supply or the pilot flame being extinguished by draught.

Automatic temperature control is provided by means of a Drayton type VT/o thermostatic pilot valve operated on the vapour tension principle and connected to a bulb immersed in the boiler water. The valve is normally set to control the flow temperature at 185° F. A 4 in. accelerator is arranged in the flow main adjacent to the boiler for pumping the hot water through the system.

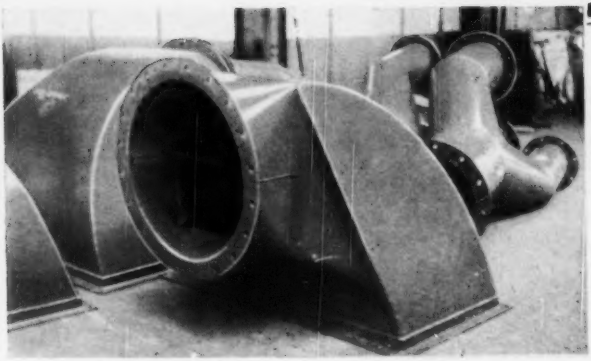
The whole of the heating installation was carried out by G. N. Haden and Son Ltd., a local firm of heating engineers.

TYNESIDE SAFETY GLASS LTD.

Another fine example of a modern central heating plant is now in operation at Tyneside Safety Glass Ltd., Team Valley Trading Estate, Gateshead. This firm is engaged in the manufacture of safety glass for the motor-car industry and gas is used on a large scale for the processing of this particular product.

Heating for the manufacturing sections of the works is provided by a number of "Dunham" overhead unit air heaters supplied with hot water pumped from the central heating plant, each unit having an output of 52,500 B.Th.U. per hour. Administrative buildings and offices are heated throughout by "Dunham" cabinet convectors.

The central heating plant consists of two 3 GBA.13 "Ideal" gas-fired hot water boilers each having a maximum rating of 1,430,000 B.Th.U.



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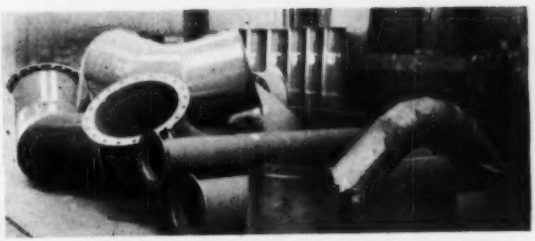

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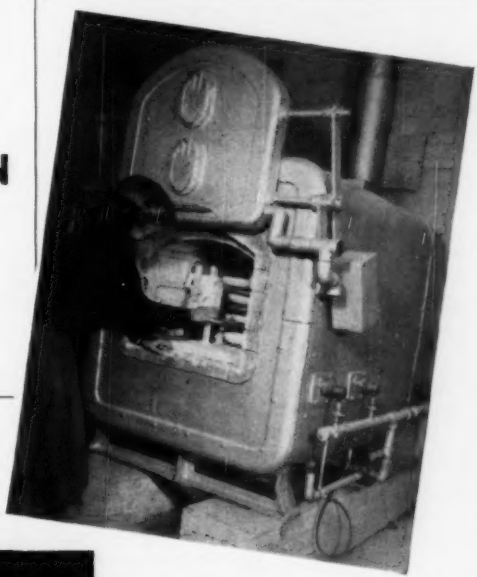

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per hour with a gas consumption of 3,575 c. ft. per hour. Space is provided in the boiler room for two additional units to cope with possible future extensions to the factory.

Gas for the heating boilers is taken from a 50 B. and M. meter through a 6 in. service pipe to a position along the rear wall of the boiler room where two 3 in. branches are taken off to supply the two sets of control equipment and burner manifolds on each unit. The controls for each set of burners includes main shut-off cock governor, and on and off gas control valve operated from a limit thermostat inserted in the boiler waterways, bi-metal type flame failure device and permanent pilot.

Steam for process and hot water for domestic purposes is provided by a 17c "Cochran Kirke" Sinuflo boiler supplying 5,075 lb. of steam per hour at 80 lb. per sq. in. gauge with a gas consumption of 15,100 c. ft. per hour.

The gas requirements for this steam raising unit is taken from a 60 B. and M. meter in the boiler room. L. Vaux, Consultants, were responsible for the whole layout, the installation being carried out by Brightside Foundry and Engineering Co. Ltd.

SCHOOL HEATING

A representative example of a modern school central heating plant which is worthy of mention is installed at the Convent De la Sagesse Secondary and Kindergarten School for Girls, Jesmond, Newcastle. The installation consists of two 3 GBA.7 "Ideal" hot water central heating boilers each having a maximum rating of 650,000 B.Th.U. per hour with a gas consumption of 1,625 c. ft. per hour. The school is heated throughout by "Ideal" Neo-Classic radiators supplied with hot water at a temperature of 175° F. from the boilers. An accelerator is arranged in the flow main to pump the hot water through the system.

The standard type of burner controls are provided and consist of governor, limit thermostat with on-off gas control valve, clock control, bi-metal flame failure device and permanent pilot. Domestic hot water for ablutions, etc., is supplied from a 2 GBA.5 "Ideal" boiler having a rating of 220,000 B.Th.U. per hour and a gas consumption of 550 c. ft. per hour. All necessary controls for this unit are enclosed inside the boiler casing.

As an indication of the simplicity in the running of this installation, one of the Sisters of the Convent attends the operation of the complete plant without assistance.

The boilers and heating system were installed by Brightside Foundry and Engineering Co. Ltd.

AIR CONDITIONING

WE have just received two interesting publications from the Sturtevant Engineering Co. Ltd., Southern House, Cannon Street, E.C.4.

The first, No. 4.001, deals with Sturtevant air washers which are made in two standard types: The short type or humidifier used in plenum ventilation plants produces a moderate cooling effect in summer and humidity suitable for human comfort in winter. The longer type provides suitable conditions for a number of air-conditioning applications.

Both types of equipment are fully illustrated by diagrammatic sketches and photographs, whilst specifications are given for the various sizes in terms of air volume in c. ft. per minute in relation to overall width and height.

In leaflet 4.002 there is a technical description of the Sturtevant viscous type air filter, which is used to remove dust which would otherwise be carried into a mechanically ventilated building, or to prevent damage to delicate apparatus, machinery, stocks and so on. There is a technical description of the method of operation together with data on dimensions and weights, the capacity, the erection of the filter and notes on the cleaning procedure.

GAS HEAT IN INDUSTRY will be sent post free every month for one year to any address in the world for 10s. 6d.

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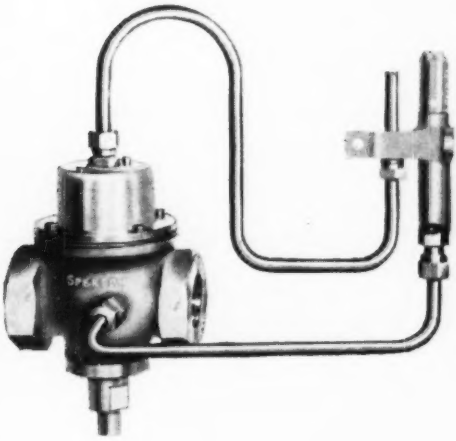

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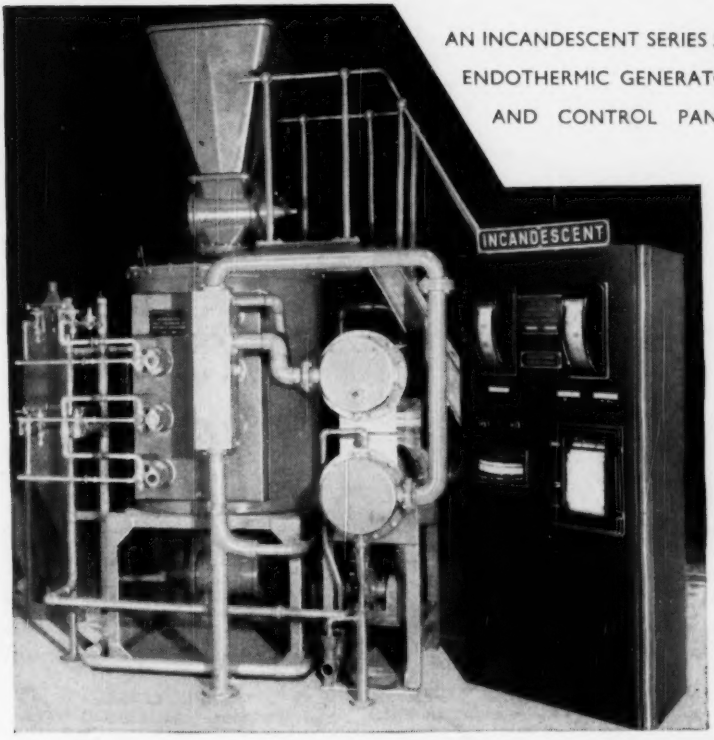

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